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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

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Development of USES Aptitude Test Battery for Micro-logic ~~Semiconductor~~ Assembler

(electronics) 726.884-080

U.S. DEPARTMENT OF LABOR
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Washington, D.C. 20210

Technical Report on Development of USES Aptitude Test Battery

For .....

Micro-logic
~~Semiconductor~~ Assembler (electronics) 726.884-080

S-381

U. S. Employment Service
in Cooperation with
Pennsylvania State Employment Service

August 1966

GATB Study #2620

DEVELOPMENT OF USES APTITUDE TEST BATTERY

For

Micro-logic
~~Semiconductor~~ Assembler (electronics) 726.884-080

S-381

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Semiconductor Assembler 726.884. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB, B-1002 Scores
Q - Clerical Perception	110
F - Finger Dexterity	75

RESEARCH SUMMARY

Sample

50 female workers employed at the Philco Corporation plant in Lansdale, Pennsylvania.

Criterion

Supervisory ratings

Design

Concurrent (test and criterion data were collected at approximately the same time)

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiences.

Concurrent Validity

Phi Coefficient = .45 ($P/2$ less than .005)

Effectiveness of Norms

Only 66% of the non-test-selected workers used for this study were good workers; if the workers had been test-selected with the above norms, 80% would have been good workers. Thirty-four percent of the non-test-selected workers used for this study were poor workers; if the workers has been test-selected with the above norms only 20% would have been poor workers. The effectiveness of the norms is shown graphically in Table 1:

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Workers	66%	80%
Poor Workers	34%	20%

SAMPLE DESCRIPTION

Size

N = 50

Occupational Status

Employed workers

Work Setting

Workers were employed at the Philco Plant in Lansdale, Pennsylvania.

Employer Selection Requirements

Education: None

Previous Experience: None

Tests: None

Other: Personal interview and past record in other departments.

Principal Activities

The job duties for each worker are comparable to those shown in the job description in the Appendix.

Minimum Experience

All workers in the sample had at least three months' total job experience.

TABLE 2

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and Experience

	Mean	SD	Range	r
Age (years)	35.38	7.19	21 - 60	-.056
Education (years)	10.80	1.43	7 - 12	.003
Experience (mos.)	10.14	6.84	3 - 22	.120

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B were administered during 1965.

CRITERION

The criterion data consisted of supervisory ratings of job proficiency made at approximately the same time as test data were collected. Ratings were made by the Production Superintendent.

Rating Scale

USES Form SP-21, "Descriptive Rating Scale." This scale (see Appendix) consists of nine items covering different aspects of job performance. Each item has five alternatives corresponding to different degrees of job proficiency.

Reliability

Since only one rating was obtained, no measure of criterion reliability is available.

Criterion Score Distribution

Possible Range:	9 - 45
Actual Range:	13 - 41
Mean:	30.72
Standard Deviation:	5.39

Criterion Dichotomy

The criterion distribution was dichotomized into low and high groups by placing 34% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high criterion group were designated as "good workers" and those in the low group as "poor workers." The criterion critical score is 29.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for try out in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitudes G and K which do not have a significant correlation with the criterion were considered for inclusion in the norms because the job analysts indicated that these aptitudes were important for the job duties and the sample had a relatively low standard deviation on Aptitude G and a relatively high mean score on Aptitude K. Aptitude Q which does not have a significant correlation with the criterion was considered for inclusion in the norms because the sample had both a relatively low standard deviation and a relatively high mean score on this aptitude. With employed workers, a relatively low standard deviation indicates that some sample pre-selection may have taken place and this restricted range of scores (low standard deviation) will depress the correlation between the aptitude and the criterion. A relatively high mean score with employed workers may also indicate some sample pre-selection. Tables 3, 4 and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis
(Based on the job analysis the aptitudes listed appear to be important to the work performed)

Aptitude	Rationale
G - General Learning Ability	Must use judgment to insure the production of acceptable electronic units
P - Form Perception	Aligns and inspects parts using a microscope; must be accurate in making visual examination and works to close tolerance of perfection
K - Motor Coordination	Must be able to coordinate eyes and hands to make precise placement of tiny component parts and to control movement of eyes and hands in picking up and placing parts of unit.
F - Finger Dexterity	Must be dexterous in using tweezers and in positioning and assembling extremely small parts

TABLE 4

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB; N = 50

Aptitudes	Mean	SD	Range	r
G - General Learning Ability	93.2	11.2	63-118	.029
V - Verbal Aptitude	94.8	11.4	70-119	-.074
N - Numerical Aptitude	97.0	15.7	59-129	.102
S - Spatial Aptitude	95.1	13.0	65-130	.023
P - Form Perception	109.2	14.2	86-140	.123
Q - Clerical Perception	115.5	13.3	84-137	.251
K - Motor Coordination	110.8	16.4	64-140	.122
F - Finger Dexterity	107.2	20.7	59-155	.340*
M - Manual Dexterity	122.5	23.0	68-173	.247

*Significant at the .05 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X				X		X	X	
Irrelevant		0		0					
Relatively High Mean						X	X		X
Relatively Low Standard Deviation	X	X		X		X			
Significant Correlation with Criterion								X	
Aptitudes to be Considered for Trial Norms	G					Q	K	F	

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of aptitudes G, Q, K and F at trial cutting scores were able to differentiate between the 66% of the sample considered good workers and 34% of the sample considered poor workers. Trial cutting scores at five-point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude trial norms, minimum cutting scores of slightly higher than one standard deviation below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores of slightly lower than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. Norms of Q-110 and F-75 provided the highest degree of differentiation for the occupation of Semiconductor Assembler 726.884. The validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .45 (statistically significant at the .005 level).

TABLE 6

Concurrent Validity of Test Norms, Q-110 and F-75

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	5	28	33
Poor Workers	10	7	17
Total	15	35	50

Phi Coefficient = .45 Chi Square (x^2) = 10.15

Significance Level = P/2 less than .005

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study did not meet the requirements for incorporating the occupation studied into any of the 36 OAP's included in Section II of the Manual for the General Aptitude Test Battery. The data for this sample will be considered for future groupings of occupations in the development of new occupational aptitude patterns.

A-P-P-E-N-D-I-X

DESCRIPTIVE RATING SCALE

(For Aptitude Test Development Studies)

Score _____

RATING SCALE FOR _____
D. O. T. Title and Code

Directions: Please read the sheet "Suggestions to Raters" and then fill in the items listed below. In making your ratings, only one box should be checked for each question.

Name of worker (print) _____
(Last) (First)

Sex: Male _____ Female _____

Company Job Title: _____

How often do you see this worker in a work situation?

- ☐ See him at work all the time.
- ☐ See him at work several times a day.
- ☐ See him at work several times a week.
- ☐ Seldom see him in work situation.

How long have you worked with him?

- ☐ Under one month
- ☐ One to two months.
- ☐ Three to five months.
- ☐ Six months or more.

A. How much work can he get done? (Worker's ability to make efficient use of his time and to work at high speed.)

☐ 1. Capable of very low work output. Can perform only at an unsatisfactory pace.

☐ 2. Capable of low work output. Can perform at a slow pace.

☐ 3. Capable of fair work output. Can perform at an acceptable but not a fast pace.

☐ 4. Capable of high work output. Can perform at a fast pace.

☐ 5. Capable of very high work output. Can perform at an unusually fast pace.

B. How good is the quality of his work? (Worker's ability to do high-grade work which meets quality standards.)

☐ 1. Very poor. Does work of unsatisfactory grade. Performance is inferior and almost never meets minimum quality standards.

☐ 2. Not too bad, but the grade of his work could stand improvement. Performance is usually acceptable but somewhat inferior in quality.

☐ 3. Fair. The grade of his work is mediocre. Performance is acceptable but usually not superior in quality.

☐ 4. Good, but the grade of his work is not outstanding. Performance is usually superior in quality.

☐ 5. Very good. Does work of outstanding grade. Performance is almost always of the highest quality.

C. How accurate is he in his work? (Worker's ability to avoid making mistakes.)

☐ 1. Very inaccurate. Makes very many mistakes. Work needs constant checking.

☐ 2. Inaccurate. Makes frequent mistakes. Work needs more checking than is desirable.

☐ 3. Fairly accurate. Makes mistakes occasionally. Work needs only normal checking.

☐ 4. Accurate. Makes few mistakes. Work seldom needs checking.

☐ 5. Highly accurate. Rarely makes a mistake. Work almost never needs checking.

D. How much does he know about his job? (Worker's understanding of the principles, equipment, materials and methods that have to do directly or indirectly with his work.)

☐ 1. Has very limited knowledge. Does not know enough to do his job adequately.

☐ 2. Has little knowledge. Knows enough to "get by."

☐ 3. Has moderate amount of knowledge. Knows enough to do fair work.

☐ 4. Has broad knowledge. Knows enough to do good work.

☐ 5. Has complete knowledge. Knows his job thoroughly.

E. How much aptitude or facility does he have for this kind of work? (Worker's adeptness or knack for performing his job easily and well.)

☐ 1. Very low aptitude. Has great difficulty doing his job. Not at all suited to this kind of work.

☐ 2. Low aptitude. Usually has some difficulty doing his job. Not too well suited to this kind of work.

☐ 3. Moderate aptitude. Does his job without too much difficulty. Fairly well suited to this kind of work.

☐ 4. High aptitude. Usually does his job without difficulty. Well suited to this kind of work.

☐ 5. Very high aptitude. Does his job with great ease. Unusually well suited for this kind of work.

F. How large a variety of job duties can he perform efficiently? (Worker's ability to handle several different operations in his work.)

☐ 1. A very limited variety. Cannot perform different operations adequately.

☐ 2. A small variety. Can perform few different operations efficiently.

☐ 3. A moderate variety. Can perform some different operations with reasonable efficiency.

☐ 4. A large variety. Can perform several different operations efficiently.

☐ 5. An unusually large variety. Can do very many different operations efficiently.

G. How resourceful is he when something different comes up or something out of the ordinary occurs? (Worker's ability to apply what he already knows to a new situation.)

☐ 1. Very unresourceful. Almost never is able to figure out what to do. Needs help on even minor problems.

☐ 2. Unresourceful. Often has difficulty handling new situations. Needs help on all but simple problems.

☐ 3. Fairly resourceful. Sometimes knows what to do, sometimes doesn't. Can deal with problems that are not too complex.

☐ 4. Resourceful. Usually able to handle new situations. Needs help on only complex problems.

☐ 5. Very resourceful. Practically always figures out what to do himself. Rarely needs help, even on complex problems.

H. How often does he make practical suggestions for doing things in better ways? (Worker's ability to improve work methods.)

☐ 1. Never. Sticks strictly with the routine. Contributes nothing in the way of practical suggestions.

☐ 2. Very seldom. Slow to see new ways to improve methods. Contributes few practical suggestions.

☐ 3. Once in a while. Neither quick nor slow to see new ways to improve methods. Contributes some practical suggestions.

☐ 4. Frequently. Quick to see new ways to improve methods. Contributes more than his share of practical suggestions.

☐ 5. Very often. Extremely alert to see new ways to improve methods. Contributes an unusually large number of practical suggestions.

I. Considering all the factors already rated, and only these factors, how satisfactory is his work? (Worker's "all-around" ability to do his job.)

☐ 1. Definitely unsatisfactory. Would be better off without him. Performance usually not acceptable.

☐ 2. Not completely satisfactory. Of limited value to the organization. Performance somewhat inferior.

☐ 3. Satisfactory. A fairly proficient worker. Performance generally acceptable.

☐ 4. Good. A valuable worker. Performance usually superior.

☐ 5. Outstanding. An unusually competent worker. Performance almost always top notch.

FACT SHEET

Job Title: ~~Semiconductor~~ Micro-logic Assembler (electronics) 726.884-080

Job Summary: Aligns and assembles a large variety of micro-wave electronic units for use in aerospace or computers and inspects units for numerous types of imperfections.

Work Performed: Aligns, inspects, and assembles a large variety of micro-wave electronic units for use in aerospace or computers: Uses tweezers or vacuum pick-up to pick up wafers and minute parts, and positions properly, using a microscope to align, etch, and inspect for numerous types of imperfections.

Picks up wafers with tweezers, places ten wafers in plastic slot holder, and runs through a series of timed rinses. Blows each wafer dry with vacuum hose and places wafers in oven for a specified bake time. Removes wafers and loads on spinner one at a time, places photo sensitive material on wafer using eye-dropper and then runs through another bake.

Prepares wafers for etching by mask alignment under microscope. Positions correctly as many as 750 circuits on wafer, fits wafer under mask to the one and only correct position or within 1 ten thousandth of an inch. Removes wafers with spatula, inspects for accurate alignment and, if satisfied, places in oven for baking. Removes with tweezers and dips in series of acids to remove oxide. Inspects developed wafers under microscope to insure acid is removed and to determine proper etching.

Tests each circuit on wafer using electrical Die Sort Circuit Tester. Adjusts circuits under probes and operates foot pedal to start tester. Tests about 1,000 circuits an hour and records information on number of wafers tested, date, lot number, type, shrinkage breakdown, and gross and net circuits.

Position wafers on block to scribe into individual circuits. Checks to insure accuracy and using microscope inspects, binds, seals, and tests. Uses tweezers to pick out good chips and places on filter paper in dish. Under microscope - uses tweezers to attach fine wires to chip and to assemble circuits into units and to stem at exact position as specified on drawing. Places cap on chip, loads unit into header binder, and aligns under microscope to insure lid is properly centered. Places in leak detector machine to check gross leakage, seals, trims, and loads carriers for final electrical testing. Inspects, packs, and records units, lot number and net and gross amounts.

(This sheet is printed in duplicate. One copy should remain as part of the Appendix in order to complete the technical report. The other copy can be removed by employment service personnel who wish to set up separate fact sheet files.)

(Be sure to compare this job description with the S-173 job description)

FACT SHEET

Job Title: ~~Semiconductor~~ Micro-logic Assembler (electronics) 726.884-080

Job Summary: Aligns and assembles a large variety of micro-wave electronic units for use in aerospace or computers and inspects units for numerous types of imperfections.

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